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BRITISH MUSEUM NATURAL HISTORY

DESCRIPTIONS OF AMERICAN UREDINEÆ, III.

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The species of *Uredineæ* to which this article is devoted embrace those forms whose teleutospores occur on grasses belonging to the tribes *Maydeæ*, *Andropogoneæ*, *Paniceæ*, *Oryzeæ*, and *Phalarideæ*. In studying the plant rusts it has been found very helpful to bring together all available material on closely related hosts. In this way we have been able to get a more comprehensive and accurate view of the limitations and variations of species, and, moreover, to detect a number of errors that have crept into the literature and led to misconceptions. To carry out this plan we have taken the material for this article from the hosts belonging to a circumscribed portion of the great family of the *Gramineæ*, rather than indiscriminately from the hosts of any part of the family, as in the previous article of the series.

The present article like the two preceding ones, is based upon the material in the authors' *Uredineæ Exsiccatæ et Icones*, each article corresponding to a fascicle. The first article was published in this journal (3:44–57) March, 1895, and the second (4:377–402) December, 1898. The first fascicle of the distribution was issued September, 1894, and the second, December, 1898.

The illustrations, which are the same for the *Descriptions* and the *Exsiccatæ*, are from camera-lucida drawings made directly from the material of the distribution. The figures and the packets have the same numbering, Arabic numbers being used to designate species, and letters to indicate the collections under each species.

The intimate association of host and parasite in case of

the *Uredineæ* makes the accurate determination of the host of the utmost importance: sometimes it is only necessary to know the genus, but more often the species must be unquestionably established in order to give full value to a specimen. But it is not enough that the name of the host should be written on the packet to make the specimen of greatest worth: there should be within the packet such fragments of the host, bits of inflorescence, fruits, leaves, stipules, or other parts not too bulky, and that may or may not be affected by the rust, as may furnish characters for independent verification, or strong presumptive evidence. Moreover, the limits of species and genera among flowering plants are not unchangeably fixed, and it sometimes becomes necessary to revise the nomenclature of the host as well as of the rust, when such characteristic fragments become very important. The more difficult the host the more imperative the need of such helps. Among grasses and sedges, especially, we have often had occasion to deplore their absence. The ligules of grasses should in particular be included, and bits of their inflorescence whenever possible.

We have experienced much difficulty in securing good material of the uredo stages for our distribution, and in some cases even for purposes of study. The idea that diagnostic characters are lacking in the uredo seems to be so widely and firmly established, that collectors do not search for this stage of a rust, and rarely collect it even when conspicuous. The idea is erroneous, however, although it seems to have support from the customary omission,or subordination, of such characters in technical descriptions. Sometimes the uredosori are much more distinctive of the species then the teleutosori, and rarely less so than are the æcidia. Specimens showing the best development of the spermogonia, æcidia, uredosori, and teleutosori should in most cases be independently collected for each species. The finest specimens are those which show one of these stages in optimum development, and

one or more of the others in much less abundance. either just beginning to appear, or nearly vanished.

Still another sort of spore sometimes occurs among grass-forms that has had special attention called to it lately by the researches of M. A. Carleton, until now only partially published (Science 13:250). It has long been recognized in *Puccinia vexans* Farl., and considered to be a peculiar teleutospore-like uredospore: but Carleton finds that it has, moreover, a peculiar manner of germination. He has given the name *amphispore* to it. We have ventured to apply the name to what has heretofore been called the uredospore of *Puccinia tripsaci*, both on account of the structure and texture, and of the association with the other spore-forms. But this assignment of its role must be accepted as somewhat tentative until opportunity is given for studying the mode of germination, which is at present unknown.

In this article we have extended and varied the use of signs for designating spore stages of the *Uredineæ*. For some time the Roman numerals, I, II, III, have been generally employed to indicate æcidial, uredo, and teleutosporic stages, respectively, and occasionally of late the spermogonial stage has been represented by O. To these we now add X for the amphisporal stage. When these signs are used in connection with specimens of *Exsiccatæ*, we have found it convenient to indicate the relative abundance of each stage by using capital forms for the dominant stages and lower case forms for deficient stages: thus ii, iii, X applied to a specimen of *Exsiccatæ*, means that it exhibits chiefly amphisporic sori, but that some more or less perfect sori of uredospores and teleutospores are present, or at least that some spores of these may be found by moderate search among the amphisori.

The first article of this series contained descriptions of species numbered from one to seventeen, the second article contained numbers eighteen to thirty-four, and the present article contains numbers thirty-five to forty-four.

35. PUCCINIA TRIPSACI *Diet. & Holw.* (1897. Bot. Gaz. 24:27).

35*a*. On *Tripsacum dactyloides* L. X, iii. Near City of Mexico, Mex., *Holway*.

ORIG. DESC. "Sori on both sides of the leaves, at first covered by the epidermis, at length erumpent, somewhat linear: uredosori cinnamon-brown, spores globose or elliptical, 30-37 by 28-33μ, epispore up to 4μ thick, chestnut-brown, echinulate, with four germ-pores: teleutospores elliptic or obovate, rounded at both ends, with a hooded thickening at apex, slightly constricted, smooth, brown, 33-41 by 20-25μ: pedicel longer than spore, firm, brownish."

SYN:

1897. *Uredo pallida* D. & H. Bot. Gaz. 24:37.

Sori amphigenous, but especially beneath, prominent, somewhat linear, 1-3 mm. long, tardily naked, encircling epidermis conspicuous.

II. Uredosori pale, uredospores nearly round to obovate, small, 13-18 by 20-26μ, colorless when dry, wall thin, echinulate, pores four, equatorial.

X. Amphisori cinnamon-brown, amphispores round or elliptical, wall thick up to 4μ, dark yellowish-brown, coarsely echinulate, 28-33 by 30-37μ, pores four, rather noticeable, equatorial; pedicel thick, fugacious.

III. Teleutosori dark brown, teleutospores elliptic or obovate, slightly or not at all constricted, smooth, dark golden-brown, 20-25 by 33-41μ, apex rounded, occasionally obtuse, considerably thickened, base rounded, pedicel as long or longer than the spore, colored, firm.

The apportionment between this species and the following one of the four or five forms of uredineous spores now known on *Tripsacum* is based upon their association in the material that has come to hand. The absolute proof of relationship must await careful field observation or

cultures. It is assumed in the first place that what were described originally as uredospores of this species are true amphispores. We use the name recently proposed by Carleton (Science 13:250) to designate a form of spore having definite physiological and morphological characters, intermediate in most respects between uredo and teleutospore, to which the uncertain term, mesospore, has heretofore been applied. In the specimens (35a) published with the present fascicle of *exsiccatæ*, the amphispores and teleutospores are well shown. In a specimen collected by Mr. Holway at Tizapan, near City of Mexico, Sept. 27, 1899 (No. 3504), the true uredospores (*Uredo pallida* D. & H.) and the amphispores are in similar manner associated. Other specimens in our possession show only one form of spore in each case. The specimens in this distribution are part of the type collection, and show amphispores and in some cases teleutospores.

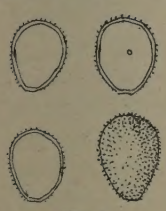

Fig. 1. UREDO PALLIDA *D. & H.* From type collected at the City of Mexico, Oct. 1, 1896.

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36. PUCCINIA POLYSORA *Und.* (1897. Bull. Torr. Bot. Club. 24:86).

36*a*. On *Tripsacum dactyloides* L. II. Cuernavaca, Mex., *Holway*.

ORIG. DESC. "II, III. Amphigenous: sori very small, short, very numerous but irregularly scattered, remaining long enclosed by the tough epidermis of the host, at length rupturing by a narrow slit: uredospores large, broadly oval, 35×30μ, scarcely echinulate, the epispore of medium thickness, pale rusty-brown: teleutospores variable, usually short, irregularly oblong, often somewhat constricted at the septum, averaging 25×40μ, the cells often irregularly angled, the upper usually broader than long, blunt or rounded above; apex not thickened; pedicel short."

The gross appearance of this species is similar to that of the preceding, except that the sori are smaller, longer

time covered, and usually more abundant. The uredospores are thin-walled, closely and finely echinulate, and have four equatorial germ-pores. The specimens in this fascicle (36a) show only uredospores, as also does a specimen in the herbarium of Mr. S. M. Tracy, collected by him at Mobile, Ala., Oct. 17, 1886, but the type collection, made by B. M. Duggar at Auburn, Ala., Oct., 1891, shows both uredo- and teleutosori. The irregular, thin-walled teleutospores (fig. 2) are very different from the teleutospores of the preceding species.

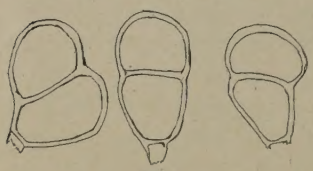

Fig. 2.
PUCCINIA POLYSORA *Und.* From type collected at Auburn, Ala., Oct. 1891.

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37. PUCCINIA VIRGATA *E. & E.* (1893. Proc. Acad. Nat. Sc. Phila. :154).

37*a*. On *Chrysopogon avenaceus* (Michx.) Benth. ii, III. Rooks Co. Kans., *Bartholomew*.

ORIG. DESC. "III. Sori amphigenous, but more fully developed on the lower side of the leaf, linear, often 1cm. or more long, erumpent and margined laterally by the ruptured epidermis, dark chestnut-brown, almost black. Teleutospores mostly wedge-shaped or clavate, but also some of them oblong, 40-70 × 18-22μ, the upper cell shorter and elliptical or subglobose and dark, the lower cell longer, narrower, and lighter colored, apex rounded and obtuse or subtruncate, and sometimes a little roughened. Epispore thickened at apex but without any distinct papilla. Has a general resemblance to *P. graminis*, but the spores are different."

SYN:

1834. *Caeoma (Uredo) andropogi* Schw. Trans. Amer. Phil. Soc. 4:290.

1896. *Puccinia clavispora* Ell. & Barth. Erythea 4:79.

1897. *Uredo alabamensis* Diet. Bull. Cornell Univ. 3:22.

Sori amphigenous, but more abundant beneath, linear, elongated, early naked, ruptured epidermis prominent.

II. Uredospores obovate, rarely subglobose, 18-30 by 28-45μ, wall reddish-brown, deeper colored at the apex, also somewhat thicker at the apex (up to 4μ), strongly and closely tuberculate, pores distinct, four, equatorial; paraphyses numerous, light brown, somewhat capitate, usually curved, wall thickened above.

III. Teleutospores clavate, cuneate or oblong, 18-22 by 40-70μ, septum above the middle, lower cell pale, thin-walled, upper cell oblong or often subglobose, dark brown, apex much thickened, rounded, obtuse or nearly truncate, pedicel thick and short.

EXSIC:

Ellis & Everhart, N. A. F., 2888, 3476.
Sydow, Uredineen, 1066.
Seymour & Earle, Econ. Fungi, 535.

This rust has proved to be a puzzling species, and no one heretofore has wholly compassed its form and habit; even now the æcidial stage is not known. Still it possesses strongly marked characters in both its uredo- and teleutosporic stages. The structure and color of the uredospores, together with the clavate paraphyses, are strongly diagnostic, while the unequal and dissimilar-celled teleutospores are fairly distinctive. The uredo stage is often prolonged without intermixture of teleutospores, especially in the eastern states. Only uredospores were known to Schweinitz, and only uredospores occur in the collection made by B. M. Duggar in Alabama, which Dietel, sixty-five years later, made the basis of a new name. We have examined type material of these descriptions, and present herewith drawings of spores and paraphyses from each (figs. 3 and 4).

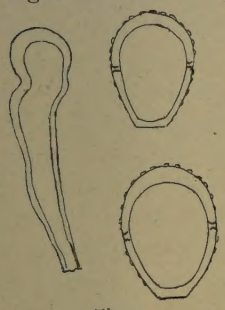

Fig. 3.
CÆOMA (UREDO) ANDROPOGI *Schw.* From type in Phila. Acad. Sci. collected at Bethlehem, Pa., 1829.

Puccinia virgata Ellis & Everhart was founded on material collected in Rooks Co., Kans., on Jan. 23, 1892

(see fig. 5), and the host determined as *Panicum virgatum*.

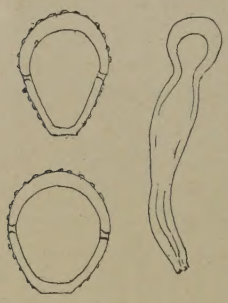

Fig. 4.
UREDO ALABAMENSIS *Diet.* From type collected at Auburn, Ala., Oct. 14, 1891.

A collection made from the type locality on May 21, of the same year, was distributed in Ellis & Everhart's N. Am. Fungi, as No. 2888. This is teleutosporic material, as would be natural in a winter collection, but a little search reveals the presence of uredospores and paraphyses, and these, together with the teleutospores, agree exactly with those of the type collection of *Puccinia clavispora* Ellis and Everhart, and of the two types already mentioned. The leaves of *Panicum virgatum* and of *Chrysopogon avenaceus* can not be certainly told apart by any characters derived from the color, texture or surface markings of the blades, but on the other hand the ligules are wholly distinct, those of the *Panicum* being prominent and fringed with long, white, silky hairs, and those of the *Chrysopogon* being still larger and entire. Diagnoses drawn from both rust and host show that these two Kansas collections supposed to be on *Panicum* are identical with *Puccinia clavispora* known to be on *Chrysopogon*, and that the host of the type of the earlier name was not a *Panicum* but was *Chrysopogon avenaceus*. It appears that with the possible exception of material found in the herbarium of the Kansas Agricultural College no collection of the supposed *P. virgata* on *Panicum* has been made since 1892, and it was then only found "on one solitary tuft of grass about two feet across" (see Bartholomew's "Kansas Uredineæ" in Trans. Kans. Acad. Sci. 16:183).

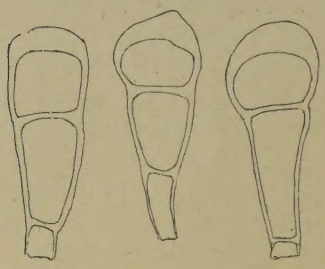

Fig. 5.
PUCCINIA VIRGATA *E. & E.* From type collected in Rooks Co., Kans., Jan. 23, 1892.

The published descriptions of *P. clavispora* and *P. virgata* also agree, except that in the latter the teleutospores are said to be "sometimes a little roughened." This can only be explained by supposing the statement to apply to the uredospores, which occur sparingly in the original material, and being colored like the teleutospores and of the same apical form, might easily be mistaken for them. So far as we know *Puccinia virgata* occurs only on *Chrysopogon avenaceus* (Michx.) Benth. (*Sorghum nutans* Gray, *Andropogon avenaceus* Michx.).

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38. PUCCINIA ELLISIANA *Thuem.* (1878. Bull. Torr. Bot. Club. 6:215).

38*a*. On *Andropogon scoparius* Michx. III. Rooks Co., Kans., *Bartholomew.*

38*b*. On *Andropogon scoparius* ii, III. Decorah, Iowa, *Holway.*

ORIG. DESC. "P. acervulis hypophyllis, gregariis, plus minusve lineariformibus, seriatis, elevatis, atro-fuscis, liberis; sporis ellipsoideis vel subclavato-ellipticis, septatis, medio vix constrictis, vertice rotundatis, incrassatis,apice rotundatis,ab pedicello separatis, episporio disseptimentoque crasso, obscuriore, 30-40 mm. long., 18-23 mm. crass., fuscis; pedicello subrecto, æquali, 18-22 mm. longo, pallidissime fusco; paraphysibus nullis — Certe a *P. andropogonis*, Fckl., diversa."

New Jersey: Newfield, in *Andropogonis virginiani* Lin., foliis aridis, Jan., 1877. Leg. J. B. Ellis."

SYN:

1895. *Puccinia andropogi* Lagerheim (non Schw.) Ured. Herb. Fries :45.

1898. *Dicæoma ellisianum* Kuntze, Rev. Gen. Pl. 3:468.

Sori as in *P. andropogonis* Schw. Uredospores yellowish-brown, thick-walled, (about 4μ), closely and finely tuberculate, subglobose, 16-24μ, mostly 20μ in diameter, pores four, equatorial, distinct: teleutospores elliptical to oblong or clavate, averaging larger than those of *P. andropogonis*, the elliptical ones 20-24 by 32-40μ, and others 16-20 by

44-52μ; apex thickened, rounded or often pointed in the oblong-clavate ones; pedicel nearly hyaline, frequently up to 80μ long.

EXSIC:

Thuemen; Myc. Univ. 1336.

That two species of rusts have been confounded under the name of *Puccinia andropogi* was first pointed out by Lagerheim in his account of the *Uredineæ* in the herbarium of Elias Fries, now in the Botanical Museum of the University of Upsala, Sweden. He was unfortunate, however, in assuming that the species having thick-walled uredospores was the true Schweinitzian *P. andropogi*.

The writers have not examined the type specimens of *Puccinia ellisiana*, but the examination of specimens in three sets of Thuemen's "Mycotheca universalis," viz., those in possession of the New York Botanical Gardens, of De Pauw University, and of Mr. Holway, which apparently contain part of the type collection, uniformly shows the presence of the characteristic uredospores. It is possible, however, that some of the following species may be intermixed, as is likely to be the case in almost any collection of this rust. It is doubtful if the host of the type collection, which was taken in mid-winter, is really *Andropogon virginicus*, as published, for the ligules of the leaves in specimens available are broad, entire, or slightly jagged, and correspond with those of *Andropogon glomeratus*, a species which grows in the type locality, instead of being narrow and ciliate, as in *A. virginicus*. But this is not a matter of moment as the species occurs upon *A. scoparius*, *A. furcatus*, and probably upon other native species of *Andropogon*, and might well occur on *A. virginicus*. The specimen in Ellis & Everhart's "Fungi Columbiana," No. 1376, on *Andropogon hallii*, is *Puccinia andropogonis*, and not *P. ellisiana* as labelled. The species doubtless ranges throughout the central and eastern United States, for specimens have been examined from different localities

in Kansas, Iowa, Indiana, Mississippi and New Jersey. It is far less abundant than the true *Puccinia andropogonis* Schw.

A rust which closely resembles *P. ellisiana* is the European *Puccinia cesatii* Schroeter (*P. andropogonis* Fckl.). This species was collected on *Andropogon furcatus* by A. B. Seymour on Aug. 22, 1884, at Brainerd, Minn., on his journey to Washington Territory, and also on *A. hallii*, by H. J. Webber, in Sept., 1889, in Howard Co., Nebraska. Both the teleutospores and uredospores resemble those of *P. ellisiana*, but the uredospores are much larger, having nearly twice the diameter, and the germ-pores, instead of being four and equatorial, are more than four and scattered. Both of the above collections have passed until now for *P. andropogi*.

The æcidia of both *P. ellisiana* and *P. cesatii* yet remain undetected.

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39. PUCCINIA ANDROPOGONIS *Schw.* (1834. Trans. Amer. Phil. Soc. 4:295).

39*a*. On *Pentstemon hirsutus* (L.) Willd. o, I. Lafayette, Ind., *Stuart.*
39*b*. On *Pentstemon albidus* Nutt. I. Rooks Co., Kans., *Bartholomew.*
39*c*. On *Pentstemon grandiflorus* Nutt. o, I. Long Pine, Neb., *Bates.*
39*d*. On *Andropogon scoparius* Michx. II, iii. Spirit Lake, Ia., *Arthur.*
39*e*. On *Andropogon scoparius* III. Lafayette, Ind., *Stuart.*
39*f*. On *Andropogon scoparius* ii, III. Lafayette, Ind., *Miss Snyder.*
39*g*. On *Andropogon furcatus* Muhl. II, iii. Spirit Lake, Ia., *Arthur.*
39*h*. On *Andropogon furcatus* ii, III. Lafayette, Ind., *Miss Snyder.*
39*i*. On *Andropogon furcatus* III. Decorah, Ia., *Holway.*
39*j*. On *Andropogon furcatus* ii, III. Rockport, Kans., *Bartholomew.*
39*k*. On *Andropogon hallii* Hack. ii, III. Cody, Neb., *Bates.*

ORIG. DESC. "449. 20. Pentastemonis Sz. A. orbiculare minus crassum purpureum subtus luteum, peridiis candidis congestis.

Non infrequens in foliis et caulibus Pentastemonis hirsuti. Distincta species. Lineas duas latum. Peridia pro ratione plantæ magna. Sporidia luteo-fusca, simplicia, vesiculosa."

SECOND DESC. "*2911. 7. P. andropogi, L. v. S., frequentissima autumno in foliis culmisque etiam vaginis variarum specierum Andropogi, Bethl.

P. maculis obliteratis, acervis dense aggregatis, elevatis, fuscis,

obtusis, linearibus, abbreviatis. Sporidiis fuscis. Quamquam non confluit, tamen fere tota folia occupat."

SYN:

1822. *Aecidium pentastemonis* Schw. Schrift. d. Nat. Ges. zu Leipzig 1:68.

1895. *Puccinia americana* Lagh. Ured. Herb. Fries :45.

1898. *Dicæoma andropogonis* Kuntze. Rev. Gen. Pl. 3:467.

O. Spermogonia few, amphigenous, bright orange when fresh: spots none or colorless: spermatia elliptical or oblong, 3-4 by 5-7μ.

I. Spots circular, yellow and splashed with purple, or with a distant purple border: æcidia mostly hypophyllous, the border low, recurved and split into few segments: spores angular, 16-18 by 18-24μ, slightly tuberculate: peridial cells quadrangular, 16-20 by 24-32 μ.

II and III. Hypophyllous: sori small, elliptical, or confluent and linear, numerous, surrounded by the ruptured epidermis: uredospores yellowish-brown, echinulate, globose, mostly 20-24μ, membrane rather thin (about 2μ): teleutospores smooth, thickened above, obovate to elliptical, 20-24 by 28-32μ, dark brown, with apex rounded, or oblong to clavate, 16-20 by 36-44μ, color paler and with apex sometimes pointed: pedicel tinted, about the length of the spore.

EXSIC:

Ellis, N. A. F., 1470 [III].
Carleton, Ured. Amer., 12 [III].
Ellis & Everhart, Fungi Columb., 1376 [III], 1457 [III].
Sydow, Uredineen, 57 [III].
Kellerman & Swingle, Kans. Fungi, 28 [I].

The cultures on which the association of æcidia and teleutospores is based were made by Messrs. Arthur and Stuart in 1899 (Bot. Gaz. 29:272). The species is very abundant east of the Rocky mountains in both the æcidial

and teleutosporic stages, but the uredo stage is of brief duration and rarely collected. Specimens gathered as early as the middle of June in central Indiana show teleutosori.

In the teleutosporic condition it is difficult to distinguish this species from the preceding. Some search, however, will usually reveal at least a few of the characteristic uredospores, even in collections made in the winter season, and the chief reliance should be placed upon these. The thin-walled echinulate uredospores of *P. andropogonis* are wholly unlike the thick-walled, small, and finely tuberculate uredospores of *P. ellisiana*.

The type specimen of *P. andropogonis* Schw. is in the Schweinitz collection of the Philadelphia Academy of Sciences. It is an ample one, in the original packet, unmounted, and labeled in Schweinitz's handwriting. The sori are very numerous. The host is not named on the packet, but appears to be *Andropogon scoparius*. The type locality is not given, but it is probably Bethlehem, Pa., as stated in the author's list of N. Am. Fungi (Trans. Am. Phil. Soc. 4:295). We have examined the type and find the characteristic, thin-walled, echinulate uredospores, and no other sort. There can be no question regarding the error of Lagerheim in supposing the Schweinitzian rust to be a thick-walled uredoform rather than a thin-walled one. No other specimen of rust on *Andropogon* occurs in the Schweinitz collection, unless one include his *Cæoma* (*Uredo*) *andropogi*, a very dissimilar form on *Chrysopogon avenaceus* (*Andropogon* of earlier authors). (See page 177.)

The specific name *Pentastemonis*, which Schweinitz gave to the æcidial form a dozen years before he employed the one we have adopted, can not be used, as there is already a *Puccinia pentstemonis* given by Peck in 1885, to a rust on *Pentstemon* found in western North America.

The form of the name as Schweinitz wrote it, was "*Puccinia andropogi*," but we have followed Schroeter, Saccardo, Kuntze, and many others in writing it *P.*

andropogonis. The Greek noun πώγων being in the third declension, a Latin derivative like *Andropogon* should be also in the third declension, and not in the second as assumed by Schweinitz and others.

The rust is very common, especially upon *Andropogon scoparius* Michx. We have examined specimens on this host collected in New York, Pennsylvania, Alabama, Louisiana, Indiana, Iowa, North Dakota, Nebraska, Kansas and Nevada. We have examined specimens on *A. furcatus* Muhl. (*A. provincialis* Lam.) from Mississippi, Indiana, Iowa and Nevada: on *A. virginicus* L. from Alabama: on *A. argyraceus* Schultes from Alabama: on *A. hallii* Hack. from Nebraska: on *Pentstemon hirsutus* (L.) Willd. (*P. pubescens* Sol.) from Alabama, Indiana and Kansas: on *P. albidus* Nutt. from Kansas: on *P. grandiflorus* Nutt. from Nebraska, and Iowa, and on *P. gracilis* Nutt. from Iowa.

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40. PUCCINIA VERSICOLOR *Dict. & Holw.* (1897. Bot. Gaz. **24**:28).

40*a*. On *Andropogon melanocarpus* Ell. III. Guadalajara, Mex., *Holway*.

40*b*. On *Andropogon melanocarpus* Ell. ii, III. Cuernavaca, Mex., *Holway*.

40c. On *Andropogon melanocarpus* Ell. II, iii. Cuernavaca, Mex., *Holway*.

40*d*. On *Andropogon contortus* L. II, III. Chapala, Mex., Holway.

ORIG. DESC. "Spots epiphyllous, purple-red, or brown and yellow; sori hypophyllous, oblong or linear; uredosori yellow, surrounded by the ruptured epidermis; spores ovate, 30-40 by 25-31μ, epispore very thick, colorless, with short spines, contents irregularly branched, or often star shaped; teleutosori firm, pulvinate, black, surrounded by the ruptured epidermis; spores elliptical, scarcely constricted, rounded at both ends, smooth, chestnut brown, apex variously thickened, (generally not over 8μ) 35-45 by 27-33μ; pedicel hyaline, firm, up to 130μ long."

This species has a uredospore of remarkable appearance. The walls are colorless and appear to be thickened like the sclerenchymatous cells of seed coats, thus forcing the

contents into star shaped forms. The scar made by the separation of the pedicel can rarely be detected. The germ-pores are also obscure. The collection on *Andropogon contortus* appears to differ from that on *A. melanocarpus*, by having more truly elliptical and thicker-walled teleutospores, but there appears to be no specific distinction. The specimens of this distribution collected at Guadalajara, Mex., are part of the type collection.

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41. PUCCINIA CENCHRI *Diet. & Holw.* (1897. Bot. Gaz. 24:28).

41*a*. On *Cenchrus multiflorus* Presl. ii, III. Guadalajara, Mex., *Holway.*

ORIG. DESC; "Sori very small, hypophyllous, scattered; uredosori surrounded by the ruptured epidermis; spores obovate or elliptical, 36-45 by 30-35μ, brown, echinulate, with equatorial germ-pores; teleutosori covered by the epidermis, black; spores oblong, mostly clavate, apex truncate, or irregularly angled, sometimes constricted, narrowed or rounded at base, 40-53 by 18-25μ, epispore smooth, brown, strongly thickened at apex; pedicel very short, brown."

The specimens in this distribution are part of the type collection. This species has also been found on *Cenchrus echinatus* L., E. Ule, Herbarium Brasiliense, No. 2549.

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42. PUCCINIA SUBSTRIATA *Ell. & Barth.* (1897. Erythea 5:47).

42*a*. On *Paspalum setaceum* Michx. II, III. Rooks Co., Kans., *Bartholomew.*

42*b*. On *Paspalum paniculatum* L. II, iii. Cuernavaca, Mex., *Holway.*

42*c*. On *Pennisetum mexicanum* Hemsl. ii, III. Patzcuaro, Mex., *Holway.*

42*d*. On *Pennisetum mexicanum* Hemsl. ii, III. Near Morelia, Mex., *Holway.*

ORIG. DESC. "II & III. Amphigenous. Uredospores globose or obovate, 19-23 by 22-30μ, ferruginous, very faintly echinulate, in minute (¼-1mm.) punctiform or elliptical sori, covered by the irregularly ruptured epidermis. Teleutospores obovate or clavate, rusty brown, distinctly constricted, upper cell mostly broader and very

slightly roughened, only moderately thickened at apex, which is regularly rounded or sometimes flattened, without any distinct papilla, very faintly striate, 27-52 by 19-23μ, on stout, short, (15-20μ) slightly colored pedicels. Sori mostly oblong and about 1mm. long, covered by the epidermis, which finally splits either along the top of the sorus, or oftener along one side, leaving it covered as if by a cap or lid.

Differs from *Puccinia paspali* Tracy & Earle in the shape of the sori, the slightly echinulate uredospores and the thick, short pedicels of the teleutospores."

Sori amphigenous, oblong, small, at first bulliform then tardily naked; ruptured epidermis prominent, sometimes stretched over the sorus in bands.

II. Sorus pale yellow; uredospores obovate or globose, 19-24 by 20-30μ; wall rather thin, yellowish-brown, finely and abundantly echinulate; pores four, equatorial.

III. Sorus brown; teleutospores oblong or obovate, dark brown, 19-24 by 28-50μ; apex more or less thickened, rounded, obtuse or slightly truncate; pedicel somewhat colored, firm, from short to the length of the spore or longer.

EXSIC:

Sydow, Uredineen 1080.

This appears to be a polymorphous species. The Kansas collections upon *Paspalum setaceum* have teleutospores with mostly broad and short pedicels, while the Mexican collections on *Pennisetum mexicanum* have mostly broad and long pedicels; otherwise the two forms appear essentially alike. But the form on *Paspalum paniculatum*, on the contrary, has smaller and more delicate spores of both uredo stage and teleuto stage, and the teleutospores are quite irregularly shaped, with short and more slender pedicels, which are sometimes attached obliquely.

Comparing this material with the type collection of *Puccinia paspali* Tracy & Earle, which was secured at New Orleans, La., upon *Paspalum virgatum* L., one is struck with the lack of distinctive characters. The uredospores of *Puccinia paspali* are like those on *Paspalum*

setaceum, only somewhat irregular in form, while the teleutospores are intermediate between those of *Paspalum setaceum* and *P. paniculatum*. The oblique irregular teleutospores of *Puccinia paspali*, and the linear sori, are the only marked characters with which to separate this species from *Puccinia substriata*, and these may be a local result of the influence of the host. We are inclined to think either that there is but one polymorphous species, or that the forms here included in *Puccinia substriata* on *Pennisetum mexicanum* and on *Paspalum paniculatum* are to be separated, making four species in all. The material at our disposal is inadequate for a definite conclusion, and it may be that cultures will be required for the final decision.

The markings on the teleutospores mentioned in the original description have not been detected by us. The upper cell is said to be "very slightly roughened" and the apex "very faintly striate." These characters do not appear in our material, either when viewed dry or wet.

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43. UROMYCES HALSTEDII *De Toni*. (1888. Saccardo, Syll. Fung. 7:557).

43*a*. On *Homalocenchrus virginicus* II, III, (Willd.) Britton. Dalles of the Wisconsin river, Wis., *Arthur*.

ORIG. DESC. "Sori mostly hypogenous, small, elongated, forming irregular rows; uredospores 22-25 by 26-30μ, elliptical, light yellow, indistinctly echinulate, tips dark; teleutosori shining black, spores wedge-shaped and quite irregular, 17-30 by 25-33μ, pedicel about one half the length of the spore. The broad free end of the spore is divided into 5-20 sharp or blunt projections, the longer with hyaline tips." Halsted, l. c.

SYN:

1887. *Uromyces digitatus* Halst. Jour. Myc. 3:138.
1889. *Uromyces halstedii* Ludw. Bot. Centrbl. 37:120.
1898. *Cæomurus halstedii* Kuntze. Rev. Gen. Pl. 3.450.

EXSIC:

Ellis & Everhart, N. Am. Fungi, No. 2227.

A very distinctive species, especially in the form of the teleutospores, and it is unfortunate that the descriptive name first given to it had to be abandoned, because already used. The sori are tardily naked: uredosori pale brown, the teleutosori blackish-brown.

The uredospores have thin walls with four to six scattered pores. The fine, abundant echinulation, although indistinct when wet, is very prominent when examined dry. Most of the spores come within 20-24 by 24-26 μ.

The teleutospores are amber-colored, with the upper part darker and brownish; lateral walls thin. The pedicels are slender and colored.

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44. PUCCINIA MAJANTHÆ (*Schum.*) *nom. nov.*

44*a*. On *Polygonatum commutatum* (R. & S.) Dietr. o, I. Decorah, Ia., *Holway*.

44*b*. On *Phalaris arundinacea* L. II, III. Sailor's Encampment, Mich., *Harper*.

ORIG. DESC. "1518. Æ. Majanthæ, macula orbicularis pallide-viridis centro flava; peridiis distantibus depressis primo flavis, demum subferrugineis, ore laciniato: laciniis subrotundis obtusis; pulvere primo aurantiaco demum cinereo ferrugineo.

In foliis Convalariæ bifoliæ. Æstate."

SECOND DESC. "47. Puc. sessilis n. sp. Schneider. Pucc. sitzend, keilförmig mit abgestützten Scheitel. In länglichen von der Oberhaut bedeckten Häufchen. An Phalaris arundinacea L. Neuhaus b. Pirscham. Sch. Schwarzwasserbruch b. Liegnitz."

1803. *Æcidium majanthæ* Schum. Enum. Pl. Saell. 2:224.

1824. *Cæoma elegans* Schlecht. in part. Fl. Berol. 2:115.

1825. *Cæoma convallariatum* Lk. in part. Sp. Plant. 2:42.

1827. *Uredo convallariarum* Spreng. Linnæi Syst. Veg. ed. sexta 4:573.

1869. *Puccinia sessilis* Schneider (as emended by Magnus). Schroeter's Brand- und Rostpilze Schlesiens :19.

1896. *Puccinia smilacearum-digraphidis* Kleb. Zeits. f. Pflkr. 6:261.

O. Spermogonia epiphyllous in small clusters, punctiform, rather prominent, orange-colored; spermatia elliptical, about 3 by 5 μ.

I. Æcidia small,, hypophyllous on yellow spots, in circular clusters, often irregularly confluent; margin nearly entire, slightly recurved; spores subglobose, 20-26 μ in diameter, peridial cells subglobose, somewhat angular, 28-32 by 24-28 μ.

II and III. Sori numerous, very small, elliptical to shortly linear, on both sides of the leaf; uredospores yellowish-brown, echinulate, obovate to globose, 24-32 by 16-20 μ, pores scattered: teleutosori black, covered by the epidermis: teleutospores oblong or wedge-shaped, more rarely shorter and elliptical, apex sightly thickened, generally darker, rounded, truncate, oblique, or rarely pointed, smooth, brown, mostly 44-52 by 16-24 μ; pedicel short or wanting; paraphyses none.

EXSIC:

Ellis, N. A. F., 229 [1], 1421 [1], 1475 [111].
Sydow, Uredineen, 95 [1], 96 [1].
Rabenhorst-Winter, Fungi Europæi, 3024, 3026a, b & c.
Thuemen, Myc. Univ., 27 [1].
Kunze, Fungi secl. exsicc., 554 [1].

The Puccinias on *Phalaris arundinacea* have been divided into several so-called physiological or biological species. Dr. Dietel defines the former as species morphologically similar, but whose teleutospores are only able to produce the æcidium from which they themselves were derived. Klebahn describes biological species as fungi that are indistinguishable morphologically, but are clearly separated from each other by the choice of host plant upon which they develop. The question has been raised whether they are entitled to this designation, or whether they are to be regarded as "biological races."

Magnus has used the term "adaptive-races," meaning parasitic fungi which for several generations have become habituated to a particular host plant, and therefore more easily infect that species than another upon which the same parasitic fungus also occurs. Klebahn says: (translated) "I would speak of biological races, when among fungi that are morphologically similar, yet infect a series of host plants, there are those that infect one host easily and abundantly, and another host with difficulty and sparingly, and also others that, conversely, infect the latter readily and the former with difficulty, and still others that infect all equally. The totality of these fungi would form the species, the last being the typical form of it and the first two biological races. From this it will be seen that *Puccinia smilacearum-digraphidis* and *Puccinia convallariæ-digraphidis* as they have shown themselves in my experiments, are to be regarded as biological species."

The following forms on *Phalaris* having teleutospores nearly or quite identical, but having æcidia on different species of hosts, have been described:

1. *Puccinia phalaridis* Plow. 1888. Jour. Linn. Soc. —:88. Infects only *Arum maculatum*.

2. *Puccinia winteriana* Magn. 1894. Hedw. 33:83. (*P. sessilis* Schneider, as used by Winter, Plowright, and Klebahn). Infects only *Allium ursinum*.

3. *Puccinia smilacearum-digraphidis* Klebahn. 1896. Zeits. f. Pflkr. 6:261. (*P. sessilis* Schneider as used by Magnus and Dietel). Infects *Polygonatum*, *Majanthemum Convallaria* and *Paris*.

4. *Puccinia convallariæ-digraphidis* Klebahn. 1896. l. c. (*P. digraphidis* Sopp.) Infects only *Convallaria*.

5. *Puccinia paridis-digraphidis* Klebahn. 1896. l. c. (*P. paridis* Plow.). Infects only *Paris*.

6. *Puccinia schmidtiana* Dietel. 1896. Ber. d. Naturf.

Ges. zu Leipzig, Jahrg. 1895-6 :198. Infects *Leucojum vernum*.

7. *Puccinia orchidearum-phalaridis* Klebahn. 1898. Zeits. f. Pflkr. 8:23, 9:155. Infects *Orchis maculata*, *Platanthera chlorantha*, and *Listera ovata*.

Puccinia sessilis was the first of these species published, and the description, based upon teleutospores collected in Silesia, would apply to all. Dr. Winter in Saxony made the first cultures (Ber. d. Nat. Ges. zu Leipzig, 1874 :41), and showed that the teleutospores of a *Puccinia* not distinguishable from *Puccinia sessilis*, produced its æcidium on *Allium*, and the experiments were repeated by Plowright in England with the same result (1887. Jour. Linn. Soc. 24:89). Magnus claimed (1894. Hedw. 33:83) that as the æcidium on *Allium* and *Arum* did not occur in Silesia where the teleutosporic type material was collected, while an æcidium was common there on all the four hosts named above under "3", therefore the name *Puccinia sessilis* must apply to the *Puccinia* producing these latter æcidia. This would require a new name for the *Puccinia* infecting *Allium*, which he accordingly called *Puccinia winteriana*.

The culture experiments in Europe have been numerous and carried on for several years, and the results seem, in general, well established. Klebahn tried growing *Puccinia smilacearum-digraphidis* for a number of seasons on *Polygonatum*, to see whether it would develop a tendency to less easily infect the other hosts. He found that it did infect *Polygonatum* more strongly than other hosts, and in his last article he says that although it is wise to guard against too hasty conclusions, he thinks that his experiments appear to indicate the possibility of a change in the character of a fungus through cultures.

This species has been called *Puccinia striatula* Peck (*Puc. linearis* Pk.), a name of uncertain application, but which is probably not to be cited as a synonym.

No cultures of this species have been made in the United States, but the collections presented herewith are so clearly indistinguishable from what Klebahn has called *Puccinia smilacearum-digraphidis* that we do not hesitate to associate the American æcidia and teleutospores.

What will be the ultimate systematic standing of biological species among the *Uredineæ* is yet uncertain. There is no gainsaying the statement that "the races of one generation of botanists often become the species of the next generation, who as they study them more minutely and carefully, discover constant marks not previously recognized." In our opinion there appears to be considerable utility and no material harm in treating the biologically distinguishable forms of *Phalaris* rust as normal species. In an address on "The conception of species as affected by recent investigations on fungi" delivered by Dr. Farlow three years ago before the American Association for the Advancement of Science, the conclusion is reached, after reviewing many specific cases including the one in hand, that "as systematic botany develops in the future it may very well become the study of races rather than species as we now consider them. In some cases, as in the *Uredinaceæ*, the time may be not far distant when this condition of things will be reached." To meet the requirement of utility and the growing tendency in systematic work we have undertaken to select the name for the forms of rust presented in this fascicle in the same manner as we would for thoroughly distinct and unquestioned species. We therefore feel it incumbent upon us to recognize the law of priority, which at once compels us to ignore such a recent, but attractively descriptive name as *Puccinia smilacearum-digraphidis*. The earliest name that we have found is by Schumann, who cites for his name but the single host, *Convallaria bifolia*, since transferred to the genus *Smilacina*, and now resting under the genus *Unifolium*. Immediately following *Æcidium majanthæ*

on the page in Schumann's work is *Æcidium convallariæ* occuring on *Convallaria majalis*, which should clearly provide the specific name for Klebahn's *Puccinia convallariæ-digraphidis*. So far as we know the latter species does not occur in this country.

Explanation of Plates.

The drawings have been made from a Zeiss microscope fitted with a D objective and No. 8 compensating ocular, and by the use of an Abbe camera lucida. They are uniformly drawn to a magnification of 625 diameters, and reduced in engraving to 470 diameters.

The essentially correct dimensions of the spores may be obtained from the plates by multiplying the measurements taken in millimeters by two, the results being in mucros (μ).

The pores shown for the uredospores do not always represent the full number, but only those that were evident. When the scar on the uredospores left by the separation of the pedicel is shown, it is placed lowermost.

Explanation of Plate I.

35*a*. Puccinia tripsaci *Diet. & Holw.*
On *Tripsacum dactyloides* L., from Mexico.
Five amphispores and four teleutospores.

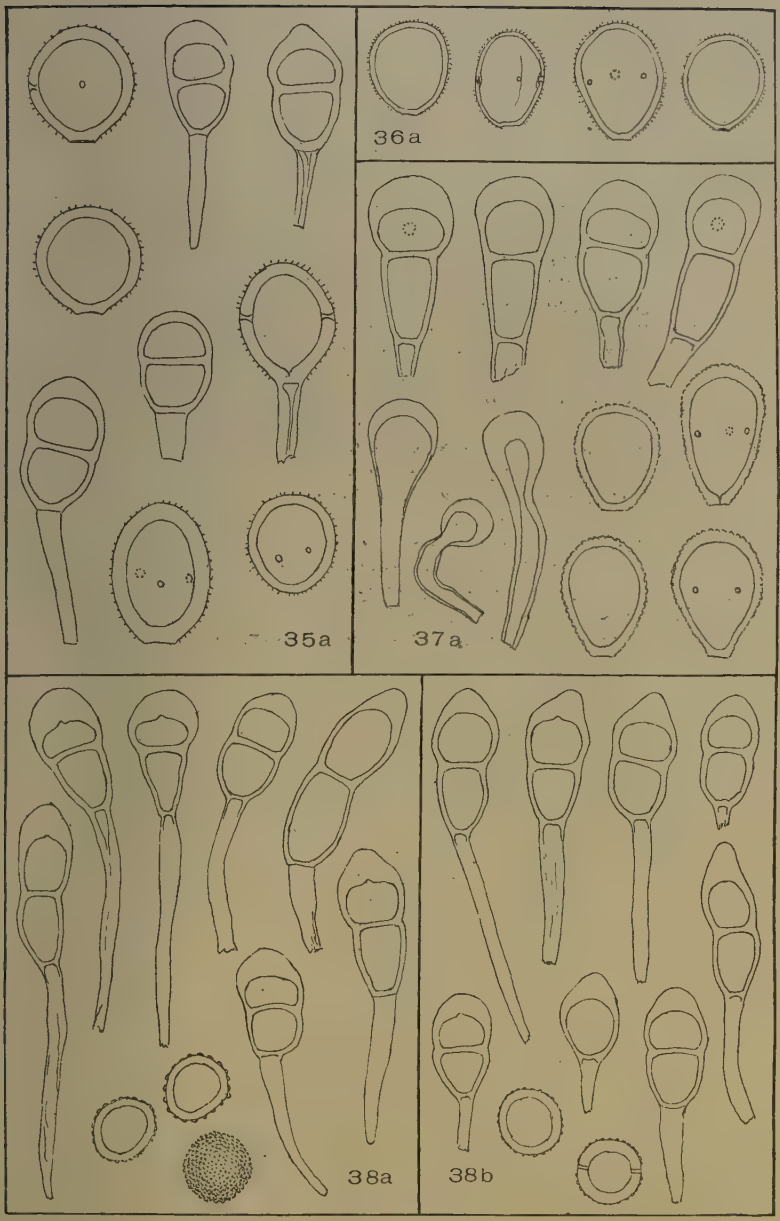
36*a*. Puccinia polysora *Und.*
On *Tripsacum dactyloides* L., from Mexico.
Four uredospores.

37*a*. Puccinia virgata *Ell. & Everh.*
On *Chrysopogon avenaceus* (Michx.) Benth., from Kansas.
Four uredospores, three paraphyses and four teleutospores.

38*a*. Puccinia ellisiana *Thuem.*
On *Andropogon scoparius* Michx., from Kansas.
Three uredospores, one drawn as if opaque, and seven teleutospores.

38*b*. Puccinia ellisiana *Thuem.*
On *Andropogon scoparius* Michx., from Iowa.
Two uredospores and eight teleutospores.

PLATE I.



Explanation of Plate II.

39*a*. Puccinia andropogonis *Schw.*
On *Pentstemon hirsutus* (L.) Willd., from Indiana.
Five spermatia and four æcidiospores.

39*b*. Puccinia andropogonis *Schw.*
On *Pentstemon albidus* Nutt., from Kansas.
Four æcidiospores.

39*c*. Puccinia andropogonis *Schw.*
On *Pentstemon grandiflorus* Nutt., from Nebraska.
Five spermatia and five æcidiospores.

39*d*. Puccinia andropogonis *Schw.*
On *Andropogon scoparius* Michx., from Iowa.
Four uredospores and one teleutospore.

39*e*. Puccinia andropogonis *Schw.*
On *Andropogon scoparius* Michx., from Indiana.
One uredospore and three teleutospores.

39*f*. Puccinia andropogonis *Schw.*
On *Andropogon scoparius* Michx., from Indiana.
Two uredospores and five teleutospores.

39*g*. Puccinia andropogonis *Schw.*
On *Andropogon furcatus* Muhl., from Iowa.
Four uredospores and one teleutospore.

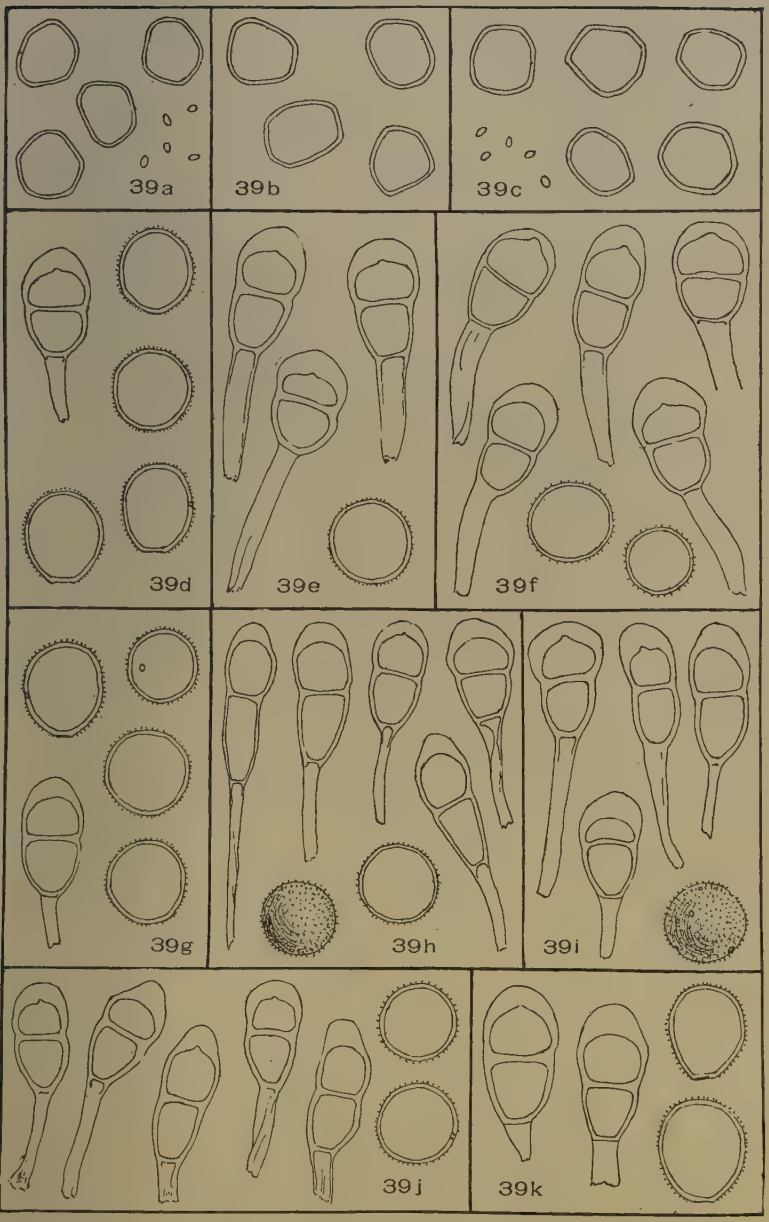
39*h*. Puccinia andropogonis *Schw.*
On *Andropogon furcatus* Muhl., from Indiana.
Two uredospores, one drawn as if opaque, and five teleutospores.

39*i*. Puccinia andropogonis *Schw.*
On *Andropogon furcatus* Muhl., from Iowa.
One uredospore, drawn as if opaque, and four teleutospores.

39*j*. Puccinia andropogonis *Schw.*
On *Andropogon furcatus* Muhl., from Kansas.
Two uredospores and five teleutospores.

39*k*. Puccinia andropogonis *Schw.*
On *Andropogonis hallii*. Hack., from Nebraska.
Two uredospores and two teleutospores.

PLATE II.



Explanation of Plate III.

40*a*. Puccinia versicolor *Diet. & Holw.*
On *Andropogon melanocarpus* Ell., from Mexico.
Two uredospores and four teleutospores.

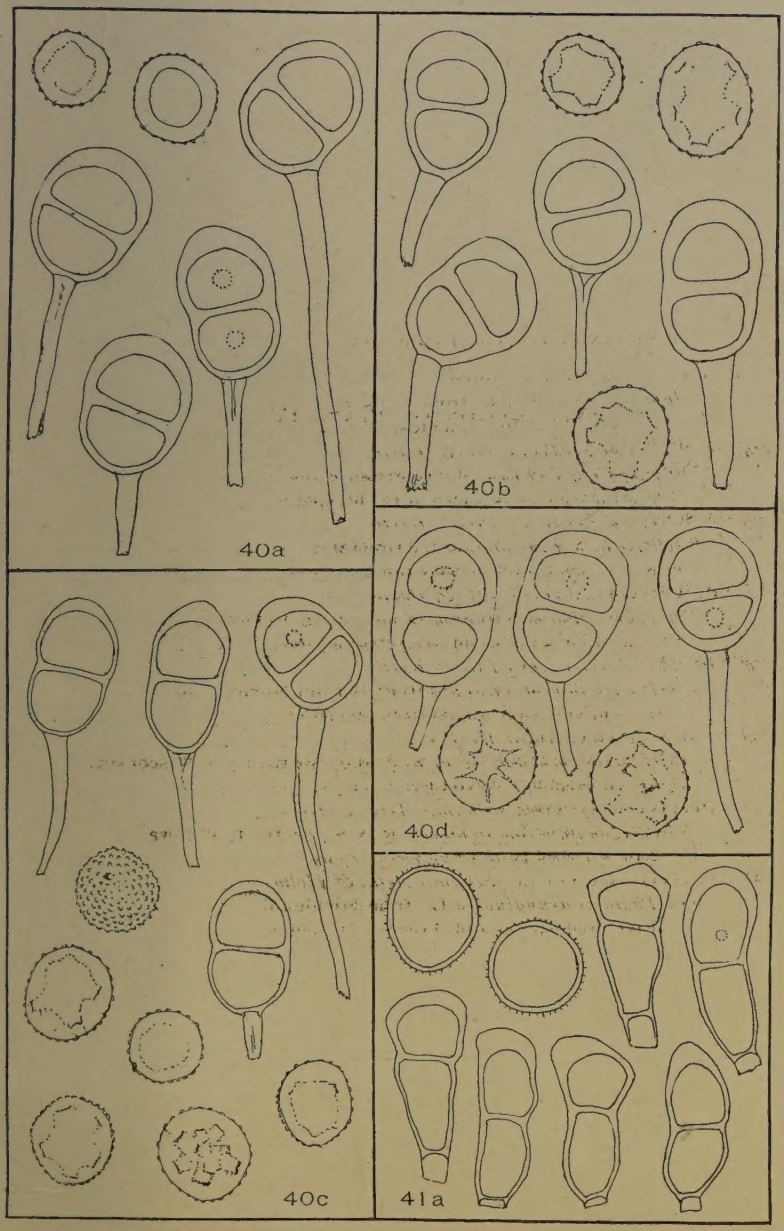
40*b*. Puccinia versicolor *Diet. & Holw.*
On *Andropogon melanocarpus* Ell., from Mexico.
Three uredospores and four teleutospores.

40*c*. Puccinia versicolor *Diet. & Holw.*
On *Andropogon melanocarpus* Ell., from Mexico.
Six uredospores, one drawn as if opaque, and three teleutospores.

40*d*. Puccinia versicolor *Diet. & Holw.*
On *Andropogon contortus* L., from Mexico.
Two uredospores and three teleutospores.

41*a*. Puccinia cenchri *Diet. & Holw.*
On *Cenchrus multiflorus* Presl., from Mexico.
Two uredospores and six teleutospores.

PLATE III.



Explanation of Plate IV.

42*a*. Puccinia substriata *Ell. & Barth.*
On *Paspalum setaceum* Michx., from Kansas.
Four uredospores and four teleutospores.

42*b*. Puccinia substriata *Ell. & Barth.*
On *Paspalum paniculatum* L., from Mexico.
Four uredospores and six teleutospores.

42*c*. Puccinia substriata *Ell. & Barth.*
On *Pennisetum mexicanum* Hemsl., from Mexico.
Four uredospores and five teleutospores.

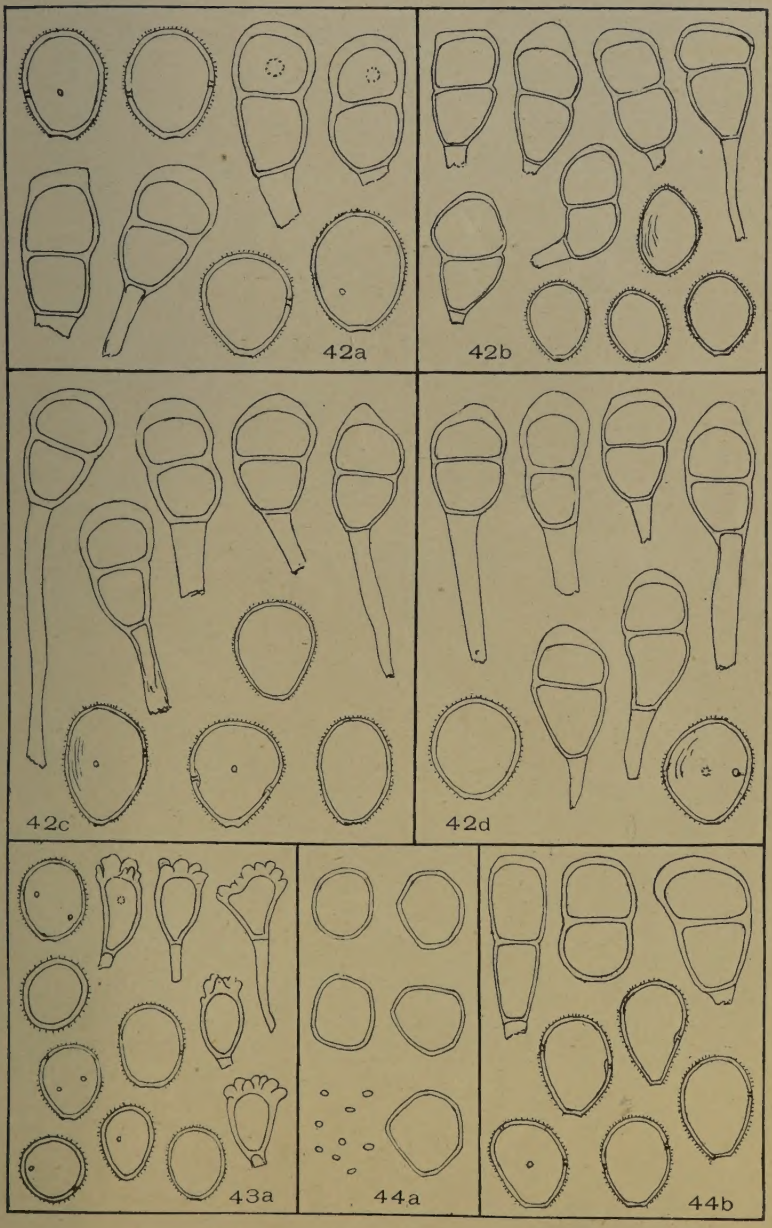
42*d*. Puccinia substriata *Ell. & Barth.*
On *Pennisetum mexicanum* Hemsl., from Mexico.
Two uredospores and six teleutospores.

43*a*. Uromyces halstedii *De Toni.*
On *Homalocenchrus virginicus* (Willd.) Britt., from Wisconsin.
Seven uredospores and five teleutospores.

44*a*. Puccinia majanthæ (*Schum.*) *Arth. & Holw.*
On *Polygonatum commutatum* (R. & S.) Dietr., from Iowa.
Nine spermatia and five æcidiospores.

44*b*. Puccinia majanthæ (*Schum.*) *Arth. & Holw.*
On *Phalaris arundinacea* L., from Michigan.
Five uredospores and three teleutospores.

PLATE IV.



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